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(54) Title: SELF-PROCESSING PLANTS AND PLANT PARTS

(57) Abstract: The invention provides polynucleotides, preferably synthetic polynucleotides, which encode processing enzymes that are optimized for expression in plants. The polynucleotides encode mesophilic, thermophilic, or hyperthermophilic processing enzymes, which are activated under suitable activating conditions to act upon the desired substrate. Also provided are "self-processing" transgenic plants, and plant parts, e.g., grain, which express one or more of these enzymes and have an altered composition that facilitates plant and grain processing. Methods for making and using these plants, e.g., to produce food products having improved taste and to produce fermentable substrates for the production of ethanol and fermented beverages are also provided.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/27129

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : Please See Extra Sheet.

US CL : Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Please See Continuation of Second Sheet.	

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/27129

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	WO 92/05259 A1 (GIST-BROCADES, N.V.) 02 April 1992 (02.04.2002), pages 21, 23, 27 and 28.	1-2,6,16- 17,19,23,28,35- 36,41-45,47,49- 50,60-61,73- 74,82,92,95,97,15 6-157 ----- 3- 5,11,18,20-22,24- 27,29- 30,46,48,51- 52,62,75,83- 87,93-94,98- 105,108-109,122- 136,150-154,158- 159,164,169- 170,214-217,233- 234
Y	5,380,831 A (ADANG et al) 10 January 1995 (10.01.1995), col. 18, Table 1.	11,30,51,62,87,94, 99-105,135- 136,152- 153,164,234
Y	5,366,883 A (ASADA et al.) 22 November 1994 (22.11.1994), col. 1; col. 3, lines 36-46; col. 9, lines 15-55; claims 1-6,8,11-12.	52,75,83,85,109,1 27-128,130- 131,134-136,151- 153,158,216,233
Y	WO 98/39461 A1 (HOWARD, John A.) 11 September 1998 (11.09.1998), page 7, line 14 through page 8, line 31; page 10, lines 7-23; page 11, lines 3-15.	3-5,19-20,24- 27,46,48,60- 62,84-87,94- 95,99-105,108- 109,122- 136,159,233-234
Y	WO 97/32986 A2 (FRIEDRICH WEISSHEIMER MALZFABRIK) 12 September 1997 (12.09.1997), page 2, bottom paragraph through page 6, first full paragraph; page 10, bottom two paragraphs; page 12, bottom paragraph through page 14, second full paragraph; page 15, bottom paragraph through page 16, top paragraph; page 19, bottom paragraph through page 20.	3-5,19-21,24- 29,46,48,60- 62,84-87,93- 95,98- 105,108,122- 136,150- 154,159,169- 170,214-217,233- 234

INTERNATIONAL SEARCH REPORT

International application No.

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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-6, 11, 16-30, 35-36, 41-52, 60-62, 73-75, 82-87, 92-95, 97-105, 108-109, 122-136, 150-154, 156-159, 164, 169-170

Remark on Protest

☐

The additional search fees were accompanied by the applicant's protest.

☐

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER:

IPC (7):

C12N 15/10, 15/31, 15/56, 15/62, 15/82, 15/84; A01H 5/00, 5/08, 5/10; C12P 19/04

A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

800/278, 284, 287, 288, 294, 310, 313, 317.2, 317.4, 320.1; 435/69.8, 101, 202, 252.2, 320.1, 412, 468, 469; 536/23.2, 23.7

B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

800/278, 284, 287, 288, 294, 310, 313, 317.2, 317.4, 320.1; 435/69.8, 101, 202, 252.2, 320.1, 412, 468, 469; 536/23.2, 23.7

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-6, 11, 16-30, 35-36, 41-52, 60-62, 73-75, 82-87, 92-95, 97-105, 108-109, 122-136, 150-154, 156-159, 164, 169-170, 214-217, 233-234, drawn to an isolated polynucleotide encoding alpha-amylase, a method of its use to transform plants, and plants transformed therewith.

Group II, claim(s) 1-5, 7, 12, 16-29, 34-35, 37, 41-50, 53, 60-61, 63, 73-75, 82-86, 88, 92-95, 108-109, 122-127, 129-131, 156-159, 168, 170, 214-217, drawn to an isolated polynucleotide encoding pullulanase, methods of its use to transform plants, and plants transformed therewith.

Group III, claim(s) 1-5, 8, 13, 16-29, 31, 35, 38, 41-50, 54-55, 60-61, 64, 73-75, 82-86, 89, 92-95, 97-105, 108-109, 122-127, 129-131, 156-159, 165, 169-170, 214-217, drawn to an isolated polynucleotide encoding alpha-glucosidase, a method of its use to transform plants, and the plants transformed therewith.

Group IV, claim(s) 1-6, 9, 14, 16-29, 32, 35, 39, 41-50, 56-57, 60-61, 65, 73-75, 82-86, 90, 92-95, 97-105, 108-109, 122-127, 129-131, 156-159, 166, 169-170, 214-217, drawn to an isolated polynucleotide encoding glucose isomerase, a method for its use, and plants transformed therewith.

Group V, claim(s) 1-5, 10, 15-29, 33, 35, 40-50, 58-61, 66, 73-75, 82-86, 91-95, 97-105, 108-109, 122-127, 129-131, 156-159, 167, 169-170, 214-217, drawn to an isolated polynucleotide encoding glucoamylase, a method for its use, and plants transformed therewith.

Group VI, claim(s) 67-72, 76-81, 160-163, drawn to a plant transformed with a gene encoding a non-starch degrading enzyme.

Group VII, claim(s) 96, drawn to an isolated starch processing enzyme.

Group VIII, claim(s) 106-107, drawn to a composition comprising isolated starch and an enzyme.

Group IX, claim(s) 110-117, drawn to a method for preparing starch granules comprising treating isolated starch granules comprising an enzyme under conditions that activate the enzyme.

Group X, claim(s) 118-119, drawn to isolated starch produced by activating starch processing enzymes present in isolated starch granules.

Group XI, claim(s) 120-121, drawn to sugars produced by chemical treatment of starch produced from isolated starch granules.

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Group XII, claim(s) 137-149, 218-220, 229-232, drawn to methods for hydrolyzing starch produced by treating isolated starch granules transformed with more than one gene encoding more than one processing enzyme.

Group XIII, claim(s) 155, drawn to a process comprising treating a plant part with a topically applied enzyme.

Group XIV, claim(s) 171-172, drawn to isolated starch produced from a plant transformed with a starch processing enzyme gene.

Group XV, claim(s) 173-174, drawn to a method for hydrolyzing a plant transformed with a non-starch processing enzyme gene for the production of a solution of sugars.

Group XVI, claim(s) 175-177, drawn to a method of treating transformed seeds with a protease or lipase enzyme to release an aqueous mixture which comprises a processing enzyme encoded by a transgene in the transformed plant.

Group XVII, claim(s) 178-188 and 195-196, drawn to a method for preparing ethanol from a plant transformed with an alpha-amylase gene.

Group XVIII, claim(s) 185, 189, and 195-196, drawn to a method for preparing ethanol from a plant transformed with an alpha-glucosidase gene.

Group XIX, claim(s) 185, 190, and 195-196, drawn to a method for producing ethanol from a plant transformed with a glucose isomerase gene.

Group XX, claim(s) 185, 191, and 195-196, drawn to a method for producing ethanol from a plant transformed with a glucoamylase gene.

Group XXI, claim(s) 185, 192, and 195-196, drawn to a method for producing ethanol from a plant transformed with a pullulanase gene.

Group XXII, claim(s) 193-194, drawn to a process for producing ethanol from a plant transformed with a non-starch processing enzyme.

Group XXIII, claim(s) 197-207, drawn to a method for producing a sweetened farinaceous food product from a transformed plant comprising a gene encoding a starch processing enzyme.

Group XXIV, claim(s) 208-211, drawn to a method for sweetening a starch-containing non-food product such as glue produced from a plant transformed with a gene encoding a starch processing enzyme.

Group XXV, claim(s) 212, drawn to a farinaceous food product.

Group XXVI, claim(s) 213, drawn to a starch-containing non-food product.

Group XXVII, claim(s) 221-222, drawn to a method for isolating an enzyme from a cultured transformed plant.

Group XXVIII, claim(s) 223-226, drawn to a process for making maltodextrin.

Group XXIX, claim(s) 227-228, drawn to maltodextrin.

Furthermore, within the elected groups above, a further lack of unity exists between each claim drawn to each isolated polynucleotide encoding a different amino acid sequence. Upon electing a group above, Applicant is required to elect a single polynucleotide from the polynucleotides encoding the following 28 amino acid sequences, corresponding to Groups XXX-LVII, respectively: SEQ ID NO: 1, 3, 5, 10, 13, 14, 15, 16, 18, 20, 24, 26, 27, 28, 29, 30, 33, 34, 35, 36, 38, 40, 42, 44, 45, 47, 49 or 51.

The inventions listed as Groups I-LVII do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The claims are linked by the technical feature of a polynucleotide encoding a starch processing enzyme such as alpha

amylase or glucoamylase, methods for plant transformation therewith, and the resultant transformed plants which produce altered starch. However, this feature is not special because it does not constitute an advance over the prior art. WO 92/05259 A1 (GIST-BROCADES) 02 April 1992 teaches transformed potato plants containing glucoamylase and alpha amylase genes, wherein said plants produce altered starch (see, e.g., pages 27-28).

Furthermore, each Group is drawn to a physiologically and biochemically divergent product, such as an isolated polynucleotide of a particular sequence encoding an enzyme of a particular activity, transformed plants, isolated starches, isolated sugars, isolated proteins, food products, and non-food starch-containing products, each not required by the other. In addition, each Group is drawn to a different process involving different starting materials, reagents, process steps, and final products, each not required by the other.